GEOFILE 756

Emergent and submergent coastlines: case studies

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Synopsis

This **Geofile** looks at emergent and submergent coastlines.

There are lots of factors that influence the appearance and formation of coastlines. Two major ones are sea level change (eustasy) and land level change (isostasy). Broadly speaking, eustasy can lead to coastlines being drowned or emerging from the sea. Isostasy is a change in the level of the land which makes it seem as if the sea level has risen or dropped. Eustasy and isostasy result in a range of landforms; these vary depending on whether the coastline is emergent or submergent, as well as other factors.

Climate change is currently having many impacts on our planet, including coastlines. As sea levels rise, low-lying coastlines in particular will be threatened by flooding. Flatter areas near to sea level will be drowned and coastlines will recede. This will have a large impact on coastal populations and settlements, including some of the world's major cities.

Key terms

Isostasy, isostatic rebound, eustasy, emergent coastlines, submergent coastlines.

Learning objectives

After studying this unit you should be able to understand the processes that have created emergent and submergent coastlines.

The case studies will give you useful examples, including the landforms associated with each type of coastline. By studying real locations you should also gain a better understanding of the forces that have shaped these different areas.

Specifications links

Exam Board	Link to specification
AQA	Component 1: Physical geography, 3.1.3 Coasts, Coastal landscape development, see page 14. http://www.aqa.org.uk/subjects/geography/as-and-a-level/geography-7037/subject-content/human-geography
Edexcel	Area of study 1: Dynamic landscapes, Topic 2: Landscape systems, processes and change, Option 2B: Coastal landscapes and change, Enquiry question 3, see page 21. http://qualifications.pearson.com/content/dam/pdf/A%20Level/Global%20Development/2013/Specification%20and%20sample%20assessments/UA035254_GCE_Lin_ASiGD_Issue%202.pdf
OCR	Landscape systems, Topic 1.1: Landscape systems, Option A: Coastal landscapes, 3 How do coastal landforms evolve over time as climate changes?, see page 10. http://www.ocr.org.uk/Images/223012-specification-accredited-a-level-gce-geography-h481.pdf
Eduqas	Component 1: Changing landscapes and changing places, Section A: Changing landscapes, 1.1 Coastal landscapes, see pages 12–3. http://www.eduqas.co.uk/qualifications/geography/as-a-level/WJEC-Eduqas-A-level-Geography-Specification.pdf?language_id=1&dotcache=no&dotcache=refresh
WJEC	Unit 1: Changing landscapes and changing places, Section A: Changing landscapes, 1.1 Coastal landscapes, see pages 14–5. http://www.wjec.co.uk/wjec-gce-geography-spec-from-2016-e.pdf?language_id=1&dotcache=no&dotcache=refresh
IB	Paper 2 Optional themes: B Oceans and their coastal margins

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Introduction

There is a wide variety of different types of coastlines, their appearance and landforms are influenced by lots of factors such as:

- geology
- relief
- human activities.

Change in sea level is another important influence. Although sea level seems to be constant it does change, perhaps most obviously over a few hours with the tides. Mean sea level has also fluctuated, and continues to do so over longer periods. Coastlines can be placed into two groups, depending on changes in the sea level. Emergent coastlines are those that have risen relative to the sea level, and submergent coastlines have dropped and become drowned.

Why does sea level change?

Sea level change is largely linked with climate change. About 2 million years ago the world's climate cooled and an ice age began that lasted until about 14,000 years ago. During the Ice Age sea level was at least 120m lower than it is today (Figure 1). Much of the water was stored as ice over land areas, and it extended out over the sea in places, as it does around Antarctica today. At the end of the Ice Age the earth's climate warmed and sea level rose.

Recently, global warming has led to sea level rise as ice sheets and glaciers melt. These changes – rises and falls – in the level of the sea are referred to as **eustatic changes**, and the process is called **eustasy**.

Changes in the level of the land can also appear to make the sea level change. Earthquakes can cause vertical movements of a few metres, which can make it seem as if the sea level has changed. Movements of the earth's plates over thousands of years can lead to larger changes in the apparent level of the sea.

From about 2 million to 14,000 years ago, the most recent ice age affected the British Isles. The land was covered with ice to a line just north of London and Bristol, known as the Thames-Severn line. The additional weight of the ice pushed the northern part of the British Isles downwards. In response, the southern part rose slightly in a pivoting movement. At the end of the Ice Age the loss of weight led to the British Isles tilting the other way – upwards in the north and west, but downwards in the south and east. Coastlines in Scotland rose above sea level, while coastlines in the south of England became submerged. The process of changes in the level of the land is called isostasy. These movements take place very slowly and the south of England is still sinking today as a result of the loss of ice and its weight at the end of the Ice Age.

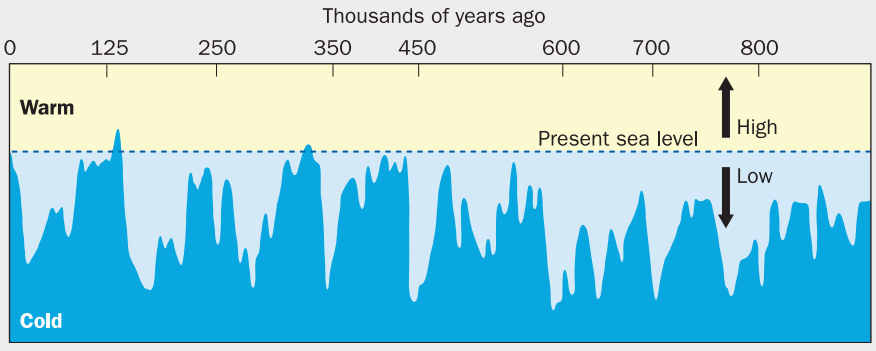

Figure 1 Global sea level change to 0.9 million years before present
Source: Based on data from NASA

Emergent coastlines

Emergent coastlines are ones that have risen or emerged from the sea. This, as we have seen, may be due to eustatic change – a fall in sea level, or isostatic change - a rise in the level of the land. Emergent coastlines have a number of features (see sketch in Figure 2).

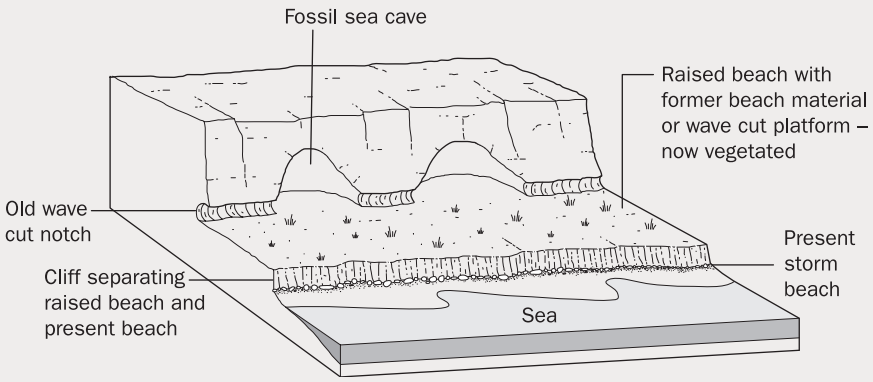

Figure 2 Sketch showing features of an emergent coastline

Case studies

Western Scotland

Much of the west coast of Scotland shows features that are typical of an emergent coastline. Gruinard Bay is a large bay about 12 km across in the west of Scotland. Since the end of the Ice Age this part of Scotland has been rising, and Gruinard Bay has a number of features typical of an emergent coast (use a search engine to find photographs so that you can see these):

- a clear ledge in the bay, that is called a **raised beach**
- towards the back of the raised beach there is a sharp rise in the level of the land that marks the position of cliffs that were once on the coast, now known as **relic cliffs**
- sometimes caves, arches, stacks and stumps can be found alongside relic (or relict) cliffs.

Although these left-over landforms are no longer being eroded by the sea, they are still being changed by weathering.

Submergent coastlines

Submergent coastlines are often known as drowned coastlines. The sea level either rises – a eustatic change or the land level falls – an isostatic change. They tend to be more complicated than submergent coastlines because the features depend on whether the drowned coastline was previously an upland or lowland area.

Submergent upland coasts: case studies

When an upland area is drowned, the water off the coast tends to be quite deep. Wave action remains strong so these are coastlines where there are more erosional landforms, such as cliffs, headlands and natural arches.

1. The coast of south-west Norway

Much of southern Norway is mountainous. During the Ice Age the landscape was eroded by glaciers. Glaciers occupied what were river valleys, and they both deepened and enlarged these. At the end of the Ice Age many of the ice caps and glaciers melted, and sea level rose. The sea went up the large glaciated valleys and drowned them, creating fiords. As Figure 3 shows, fiords have many of the features of a glaciated landscape:

- They are relatively straight landforms like many glaciated valleys.

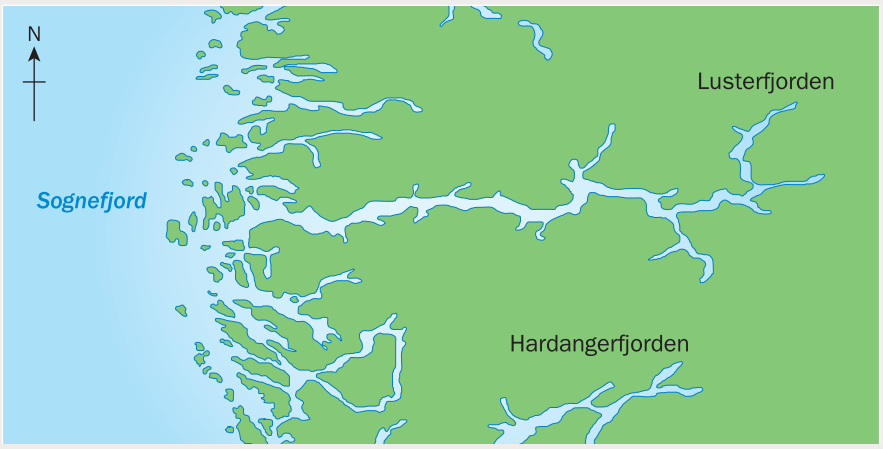

Figure 3 Sognefjord, Norway

- A fiord has steep, near vertical sides and a U-shaped cross-section.
- Hanging valleys join fiords at near right-angles and the drop is marked by large waterfalls.
- Spurs created by the action of rivers have had their ends eroded away, creating truncated spurs.
- The mouth of a fiord can be marked by a lip called a threshold where the water is shallower. This is the result of reduced erosion near the glacier's snout and possibly moraine material that was deposited there as well.

Figure 5 Dalmatian Coast, Croatia: aerial view of island of Mljet, Dubrovnik archipelago
Copyright: OPIS Zagreb/Shutterstock

2. South Devon

There are rather similar features to fiords in south Devon, shown in Figure 4. The coastline has a number of elongated and branching drowned valleys called rias. They are a different shape and depth from fiords, but were formed in a similar way. Rias are drowned river valleys. They formed at the end of the Ice Age when sea level rose.

Figure 4 shows their main features:

- They have a branching shape (like a tree) where small tributary valleys join.
- They are more winding, like a river valley, rather than straighter like glaciated valleys.
- The cross-profile is V-shaped rather than U-shaped.
- The sides are gentler than fjords.

An atlas map of the south coast of Devon and Cornwall will show such inlets clearly.

Figure 4 Rias on south Devon coast

The Exe and Teign estuaries are good examples. You can find others.

3. The Dalmatian Coast of Croatia

The Adriatic coast is characterised by many long, slim islands lying parallel to the coastline. This part of Europe was originally lines of folded ridges with valleys in-between, parallel to the coast. At the end of the Ice Age, when sea levels rose, the lower valleys were flooded and also any low points between the hills or ridges. The higher ground remained above sea level and formed the pattern of islands we see today.

Submergent lowland coasts: case study

When lowland areas are drowned, the water along the coast tends to be relatively shallow. At low tide, extensive areas of sand and mud are exposed. The shallow water slows

Figure 6 Essex coast
Copyright: Paul Wishart/Shutterstock

approaching waves and encourages deposition. These are coastlines where depositional features, such as areas of salt marsh, and landforms like dunes, spits and bars, are common.

Essex

We have already learned that southern England has experienced isostatic rebound and a gradual sinking since the end of the Ice Age. There has also been eustatic adjustment associated with melting ice at the end of the Ice Age. Many parts of the coastline of southern England show submergent features.

Figure 6 shows a typical drowned lowland coastline. Many of the features will show clearly on an Ordnance Survey map. The relief in this part of East Anglia is very flat. As the land sank and sea levels rose, the land near the coast was easily submerged and produced a typical environment for a drowned lowland coast:

- Where rivers reach the coast, wide shallow estuaries have developed, their branching shapes reflecting the position of smaller tributaries, not unlike the rias of the South coast of Devon and Cornwall.
- These estuaries have relatively shallow water and are areas where rivers deposit sediment. At low tide wide areas of mud and sand are revealed.
- Along the coast, wide sandy beaches are exposed at low tide.
- The shallow and sheltered water also allows large areas of salt marsh to develop.

Conclusion

The coastlines we have studied have been shaped in the past by various processes over many thousands of years. Processes of erosion, weathering, tectonic plate movement and climate change continue today.

Global warming is currently having dramatic effects on world sea levels.

- In Britain, rising sea levels are threatening coastlines which are weak, such as those in Norfolk and Suffolk. At Mappleton the coast is eroding by about 2 metres each year.
- Coastal flooding will be an increasing problem in low-lying parts of the world like Bangladesh and the Gulf Coast of the USA. Cities like Venice, New Orleans and London will be threatened. This will affect where people live and the economy of these areas; many of the endangered cities are important ports and financial centres.
- Low-lying agricultural areas will no longer be able to provide food and raw materials. Flooding can destroy crops and livestock and also add salt and pollution to the land.
- There can be positive outcomes, though, as new natural environments like salt marsh, important habitats for wildlife and vital resting and feeding areas for migrating birds are created.

Websites

General

http://environment.nationalgeographic.com/environment/global-warming/big-thaw/#page=1

Fiords

http://education.nationalgeographic.co.uk/encyclopedia/fjord/

Focus questions

1 What are the differences between isostasy and eustasy?

2 a) Use the following table to summarise the main features of a fiord and of a ria.

Cross-section shape	
Plan shape (is it fairly straight, or winding?)	
Sides (steep or gentle?)	
Other features	

b) Use the table to help you explain how a fiord forms. (You could answer this question for other landforms such as rias, raised beaches, etc.)

3 Essay question: Explain how sea level rise is likely to impact on coastal environments and the people living there.

Learning checkpoint

1 What is meant by the terms isostasy and eustasy?

2 List the reasons why submergent upland and lowland coasts are so different?

3 What landforms are associated with emergent and submergent coastlines?

4 Use these headings to explain how sea level rise will affect coastal environments:

- Population
- Farming
- Economic
- Natural environment